Dynamic Energy Efficient Distance Aware Protocol for the Cluster Head Selection in the Wireless Sensor Networks

Maddali M.V.M. Kumar
Department of CSE, Acharya Nagarjuna University, Guntur, Andhra Pradesh, India
mvmkumar.m@gmail.com

Dr. Aparna Chaparala
Department of CSE ,RVR&JC College of Engineering, Guntur, Andhra Pradesh, India
chaparala_aparna@yahoo.com

Abstract—Wireless Sensor Network is most important mechanism for the data gathering and data acquisition system which is implemented in all the industries such as the medical, defense, auto-motives etc. Wireless Sensor network normally consist of the main cluster head connected with all other nodes. The selection of the Cluster head is the main problem in which the energy requirement is large because of its nature of collecting the data's from all other nodes. The cluster head requires the largest energy so that it can accommodate the whole networks Several Algorithms were proposed for this problem and new algorithm which is been proposed is Dynamic Energy Efficient Distance Aware (DEEDA) for the Energy Efficient Cluster selection mechanisms in the Wireless Sensor Networks. The primary principle is selection of cluster head is based on the principle of RED (Residual Energy and Distance) Algorithms. The proposed protocol has been simulated using MATLAB and compared with other existing protocols.

Keywords—DEEDA, Wireless, RED, CH, Residual Energy.

I. INTRODUCTION

The advances in communication technology have made to the development of intelligent, lightweight, low cost sensor nodes that cooperatively collect data from the place of deployment. The nodes have been designed for the one to one communication among the different applications A node has been formed with the basic sensors, cpu and the transceivers.

The formation of the nodes has been designed based on the applications such as the defense, medical and consumer. It provides the tremendous applications in the wearable also. It can be integrated in the static environment and mobile environment for the monitoring various applications. Since the applications increases, the energy consumption in the WSN also increases which in term introduces the many energy efficient algorithms for the Wireless sensor networks.

One such mechanism is Clustering mechanism which is used to save energy in WSNs. Clustering deals with the organizations of the sensor nodes into different groups called clusters. In one and each cluster, sensor nodes are given different roles to play, such as cluster head, ordinary member node, or gate way node. A cluster head is a group leader for each cluster that collects sensed data from the different nodes in the network. The data which is collected from the cluster is passed to the sink for the further processing. The processing of data from the different nodes to the cluster takes a vital energy in terms of the consumption.

In the DEEDA algorithm, energy consumption mechanism for the cluster has been proposed. In which the energy consumption has been achieved based on the distance and the signal strength. The Cluster head selection is based on the RED (Residual Energy and Distance) principles. The intelligent selection of the cluster is done and energy consumption is compared with the other algorithms like LEECH etc.

The paper has organized as the Explanation of the algorithm in the next section, results and comparison, conclusion in the preceding sections.

II. DEEDA ALGORITHMS

DEEDA Algorithm works in two different phases which has been explained as follows. In this algorithm RED algorithm plays an important role in the selection of the cluster head mechanism.

DEEDA Algorithms works on the two different phases as mentioned below. The Phase I deals with the selection of the Cluster head by using the RED principles in which the Energy and distance has been taken into some considerations. The Rank system has been provided for the selection of cluster heads.

The Phase II deals with the Communication between the cluster head with the other nodes based on the distance.

A. Phase – I: Selection Of Cluster Heads:

1) Initial Phase:

At the Initial Phase, SINK sends the beacon message to the nodes which is present in the scenario as shown in Fig.1

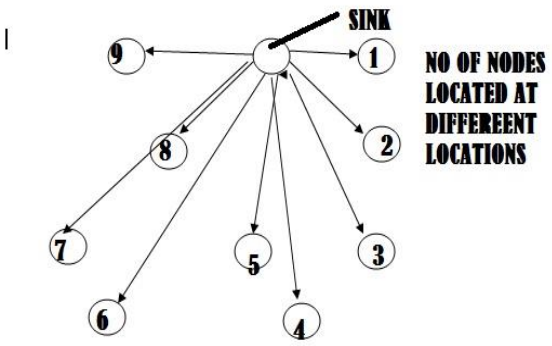

Figure 1. Shows the Beacon Message for taking decision of Cluster Head

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2) Distance Calculation:

Once the nodes receive the beacon message from the sink it calculates the RSSI (Received Signal Strength Indicator) by the formula in which the distance is calculated and the residual energy has been calculated and sent as the frame to the sink, the frame format of the Sink has been given in the format which is given as follows,

S.B	DISTANCE	RES.ENR	DATA	D.A	STOP

S.B-START BIT

DISTANCE-DISTANCE

RES.ENR-RESIDUAL ENERGY

DATA-DATA

D.A-DESTINATION ADDRESS

STOP-STOP BITS

After the distance has been calculated according with the Energy mechanisms. With the probability of taking the Highest Rank for Cluster head in accordance with the two parameters Energy and Distance.

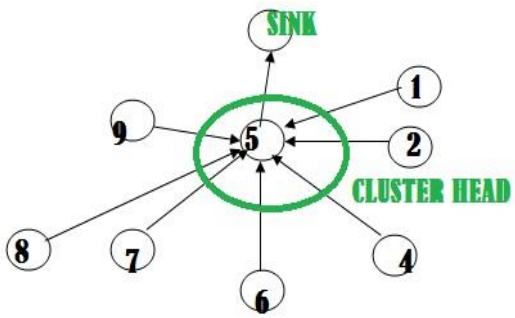

Figure 2. Selection of Cluster head From the Nodes based on RANK principles

If the node with the Least Distance has minimum residual energy, the next least distance will be selected based on the energy by using the RED Principles mentioned above.

3) Decision Phase:

The Sink decides the Cluster Head Based on the RED Rule Sets which is given as follows

F (C, E) ===$\{$ F(Et, d) Otherwise

0

Where F (C, E) - Selection of Cluster Head based on Energy

Et-Energy Threshold which is equal to the Maximum Energy is shown in Fig.2

D-least Distance from the Sink to the Node.

If the node with the Least Distance has minimum residual energy, the next least distance will be selected based on the energy by using the RED Principles mentioned above.

B. Phase – II: Routing Principle:

Based on the Cluster Head Selected, adaptive Energy based routing will take place among the nodes which can be considered as one-hop communication.

1) Mathematical Model:

The mathematical model for the different phases is given as follows as

The Distance is measured depends on the Received Signal Strength Indicator (RSSI) which is given by

RSSI (dBm)=-[10×n×log(d)+J] - (1)

RSSI is the RSSI value received (dBm)

n is the path-loss exponent

d is the distance

J is the RSSI value at a reference distance (1m)

Hence the Distance can be calculated by

Distance = 10^[J+RSSI]/(10+n) - (2)

RED principles is implemented in the sink to decide the RANK for which the cluster head is selected which is given by the model

R(Ch) = Enn > Eth

Dnn <Dt

Where R(Ch) - Rank of the Cluster head

Enn = Energy of the Nodes at Different Distance

Eth = Grade of the threshold Energy

Dt = Grade of the threshold Energy

Dnn = Distance from the Different nodes.

Cluster head is selected is given in the following table:

TABLE I. WORKING MECHANISM OF THE RED PRINCIPLES AND SELECTION OF THE CLUSTER HEAD MECHANISMS

Iteration	Rank given	Energy	Distance
01	01	Large	Small
02	02	Medium	Medium/Small
03	03	Small	Large/Medium/Small

2) Overall Working Principle:

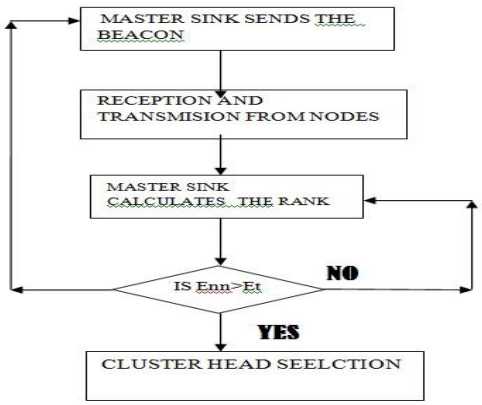

Figure 3. Flow Diagram for the DEEDA principles of Working

III. RRESULTS AND DISCUSSION

The DEEDA algorithms have been tested with the MATLAB R2016 with following parameters which is given in Table 2.

TABLE II. SIMULATION SETUP

Parameters Used	Details of the Parameters
Nodes	50
No Of Sink Used	01
Area	100 m
Indoor/Outdoor	Indoor
Protocols Tested	ZigBee / Bluetooth
No of Data Bytes	8 bits / Sec

In the testing environment, data bytes of the cluster head are calculated in respective to the no of iterations of the data transfers.

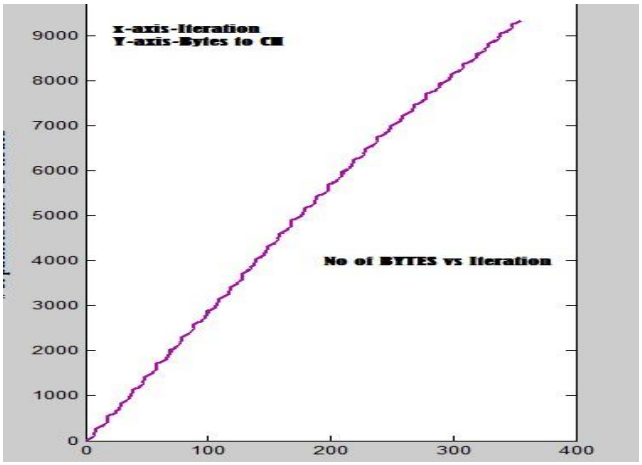

Figure 4. Shows the Data Bytes of the CH Selected with iterations.

Again the Energy is calculated for the no of bytes transmitted for the iteration and it is shown in Fig.5

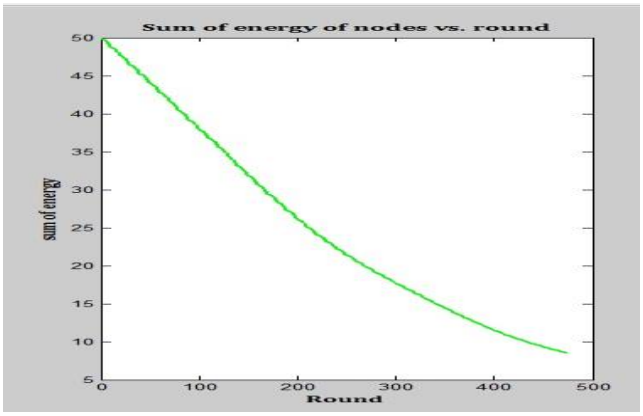

Figure 5. Shows the Energy Consumption of the CH with respective to the iterations

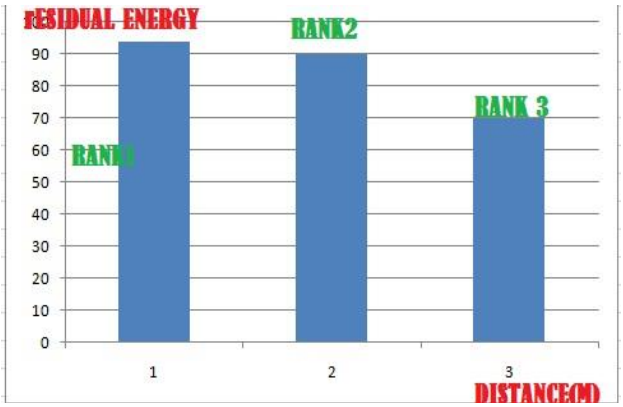

Figure 6. Selection of Cluster HEAD based on RED principles

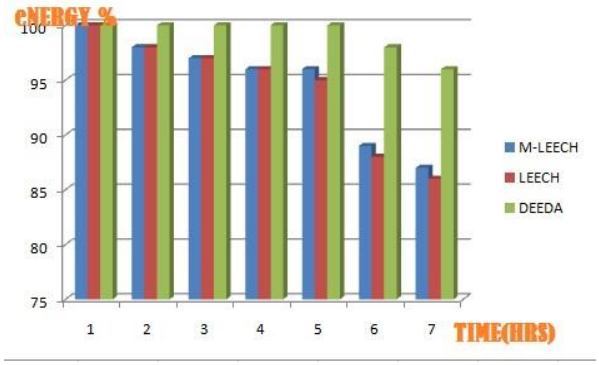

Figure 7. Comparative Analysis of the different Protocols in DEEDA outperforms the both.

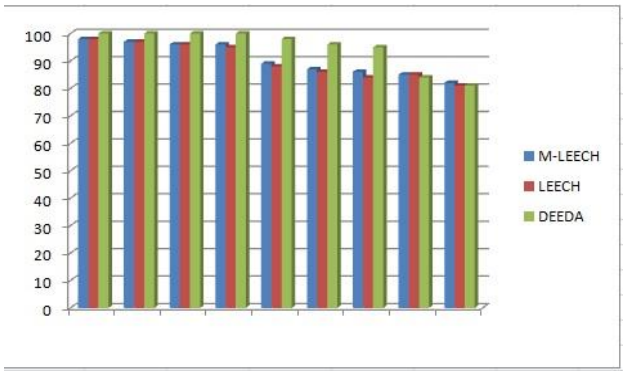

Figure 8. Comparative Analysis of the Energy Consumption of different algorithms for respective to iterations of longer time.

CONCULSION

DEEDA Algorithm outperforms in terms of Energy Saving and energy consumption of the Cluster Head when compared with the existing algorithms. The proposed algorithm can be integrated for increase in lifetime of the nodes. In addition, it can be implemented along with the Energy harvesting mechanisms for the increased lifetime and performance of the system.

REFERENCES

[1.] Xiaoming Zhou, Chengzhi Long, Xiao Lu, "A Multi-hop Cluster Routing Algorithm Based on Max-min Distances Method", Journal of Information & Computational Science 12:4 , March 2015 , pp.1579 - 1586.

[2.] Rongbo Zhu, Yingying Qin, and JiangqingWang, "Energy-Aware Distributed Intelligent Data Gathering Algorithm in Wireless Sensor

Networks", HindawiPublishing Corporation International Journal of Distributed Sensor Networks Volume, April 2011, Article ID 235724, pp.1-13.

[3.] Yinying Yang, Mirela. Fonoage, MihaelaCardei, "Improving network lifetime with mobile wireless sensor networks", Elsevier, Computer Communications 33 (2010), pp. 409–419.

[4.] Wei-Peng Chen, Jennifer C. Hou and Lui Sha, "Dynamic Clustering for Acoustic Target Tracking in Wireless Sensor Networks", Proceedings of the 11th IEEE International Conference on Network Protocols (ICNP'03) 1092-1648/03, 2003, IEEE.

[5.] Qian Dong, WaltenegusDargie, "A Survey on Mobility and Mobility-Aware MAC Protocols in Wireless Sensor Networks ", IEEE Communications Surveys & Tutorials, Vol. 15, No. 1, First Quarter 2013, pp.88 – 100.

[6.] Hengyu Long, Yongpan Liu, Yiqun Wang, Robert P. Dick, Huazhong Yang, "Battery Allocation for Wireless Sensor Network Lifetime Maximization Under Cost Constraints" IEEE/ACM International Conference on Computer-Aided Design - Digest of Technical Papers, ICCAD 2009., November 2–5, 2009, pp. 705 – 712.

[7.] Ch. Antonopoulos, A. Prayati, T. Stoyanova, C. Koulamas, G. Papadopoulos, "Experimental Evaluation of a WSN Platform Power Consumption",IEEE International Symposium on Parallel & Distributed Processing, 23-29 May 2009 (IPDPS 2009), pp.1-8

[8.] JeongGilKo and Marcus Chang, "WirelessoRo: Providing Mobility Support for Low-Power Wireless Applications", IEEE Systems Journal, Vol. 9, No. 2, June 2015, pp. 585 – 594.

[9.] Can Tunca, Sinan Isik, Mehmet YunusDonmez, and CemErsoy, "Ring Routing: An Energy-Efficient Routing Protocol for Wireless Sensor Networks with a mobile Sink", IEEE Transactions on Mobile Computing, Vol. 14, NO. 9, September 2015, pp. 1947 – 1960.

[10.] Fatme El-Moukaddem, Eric Torng, and Guoliang Xing, "Maximizing Network Topology Lifetime Using Mobile Node Rotation", IEEE Transactions on Parallel and Distributed Systems, Vol. 26, No. 7, July 2015, pp. 1958 – 1970.

[11.] FarzadTashtarian, Mohammad Hossein Yaghmaee Moghaddam, KhosrowSohraby and SohrabEffati, "On Maximizing the Lifetime of Wireless Sensor Networks in Event-Driven applications With Mobile Sinks", IEEE Transactions on Vehicular Technology, Vol. 64, No. 7, July 2015, pp. 3177 – 3189.

[12.] Mohammed Abo-Zahhad, Sabah M. Ahmed, Nabil Sabor, and Shigenobu Sasaki, "Mobile Sink-Based Adaptive Immune Energy-Efficient Clustering Protocol for Improving the Lifetime and Stability Period of Wireless Sensor Networks", IEEE Sensors Journal, Vol. 15, No. 8, August 2015, pp.4576 – 4586.